2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER)

Automatic topology identification of weak low voltage networks and load management strategies for micro-mobility applications

Babak Ravanbach, *DLR Institute of Networked Energy Systems*

Peter Klement, Jannick Helms, Luis Granja, Benedikt Hanke, Karsten von Maydell

Babak Ravanbach

Renewable Energy Scientist

+ Engineer, Designer, Manager, Lecturer

Education

MS, Renewable Energy

Oldenburg University

BS, Electrical Engineering

University of California, San Diego

Research

Household & Community E-Profiles

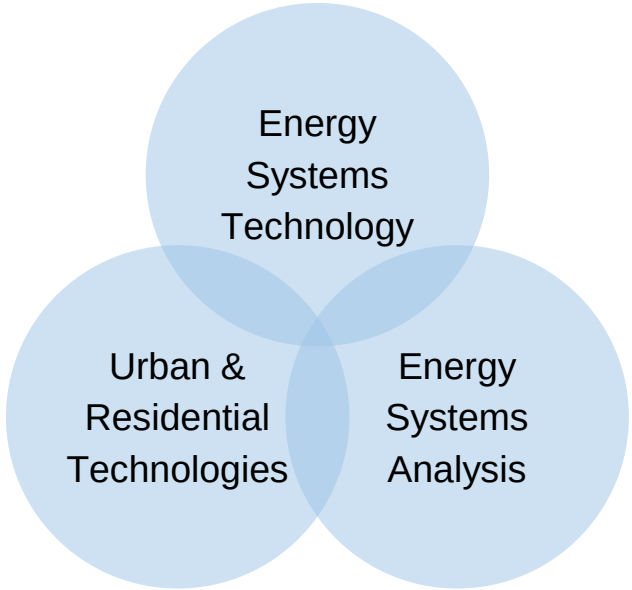
Smart Energy Management

Renewable Energy Mini-grids

DLR Institute of Networked Energy Systems

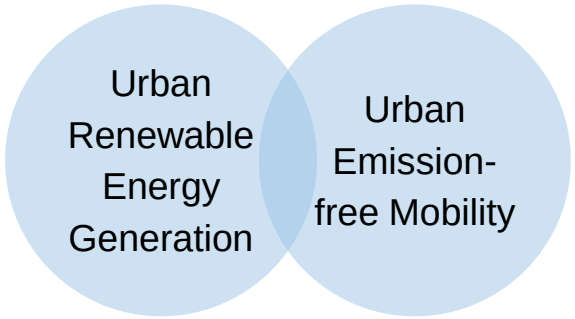
Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

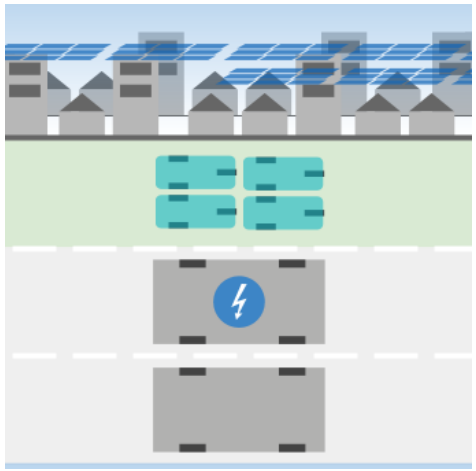
Institute of
Networked Energy Systems



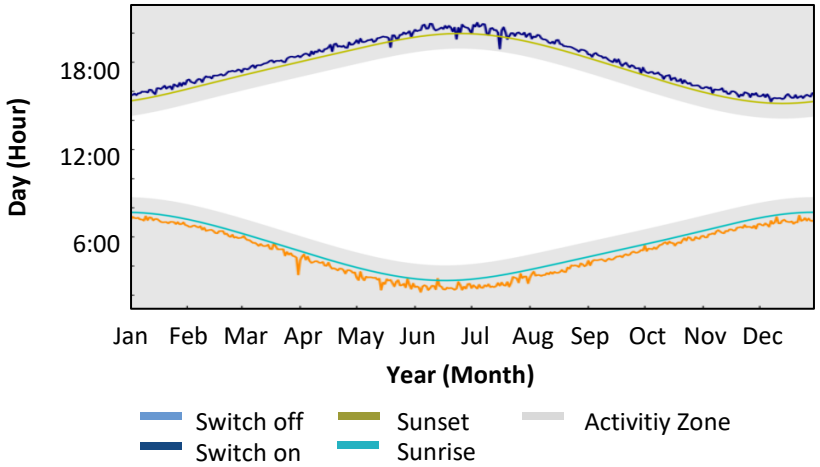
Motivation

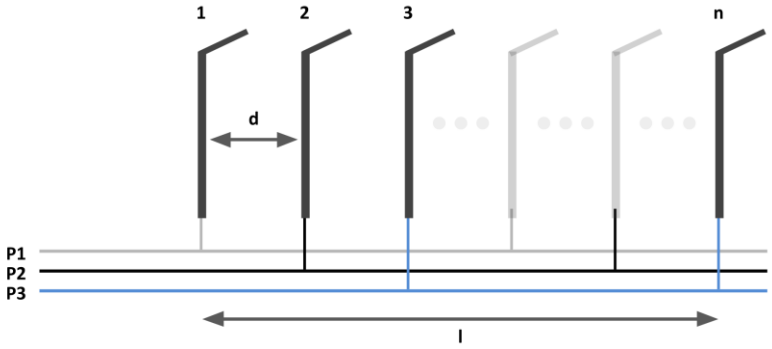
- Integration of sustainable e-mobility solutions in the urban infrastructure
- Managing a dynamic combination of generations and loads on an existing infrastructure that is designed based on a set of particular standards and specification to support its static original conditions.

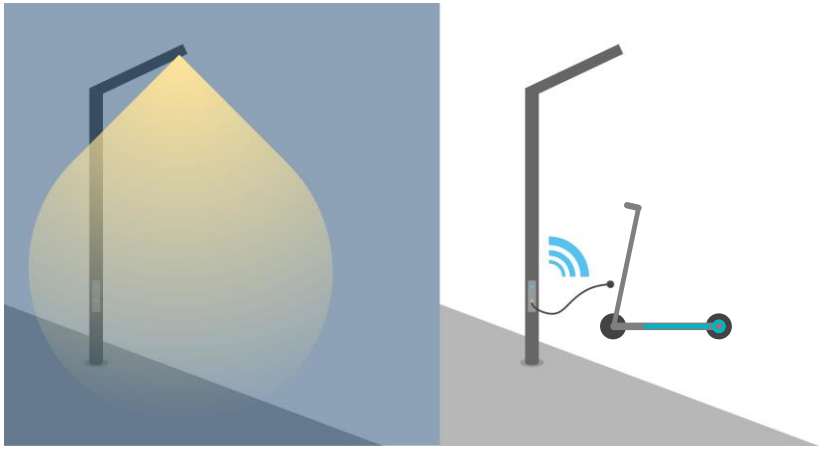


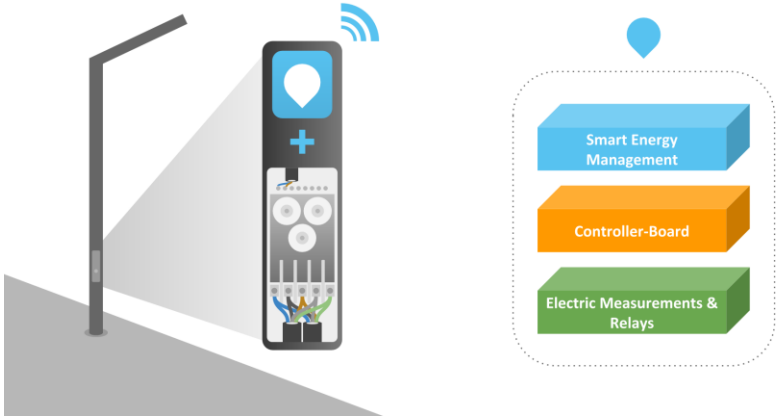


Smart Poles

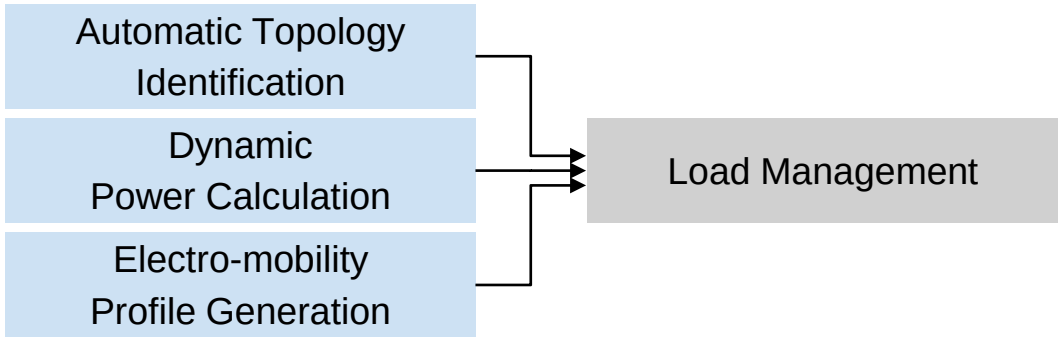

18:00
12:00
6:00
Day (Hour)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Year (Month)
Switch off
Switch on
Sunset
Sunrise
Activitiy Zone


1
2
3
n
d
P1
P2
P3
l




Smart Energy Management
Controller-Board
Electric Measurements & Relays

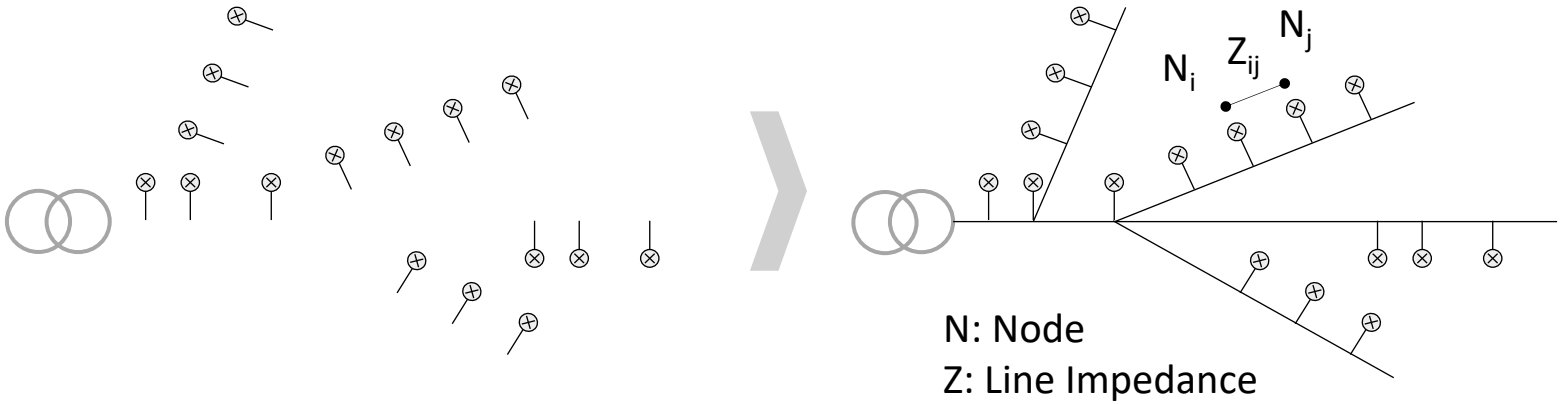
Load Management



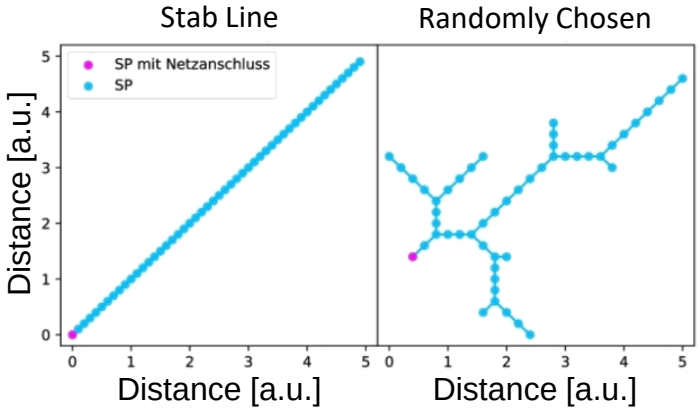
- The load forecast analyzes past load profiles and creates a prediction of the expected loads for the network.
- The optimized load flow ensures compliance with permissible tolerances and creates timetables for producers and consumers.
- The state estimation provides data for the assessment of the network status and enables the warning of potentially inadmissible behavior in the network.
- The network security calculation carried out before and during network faults, anticipates the failure of equipment and the effects of interferences in operation.

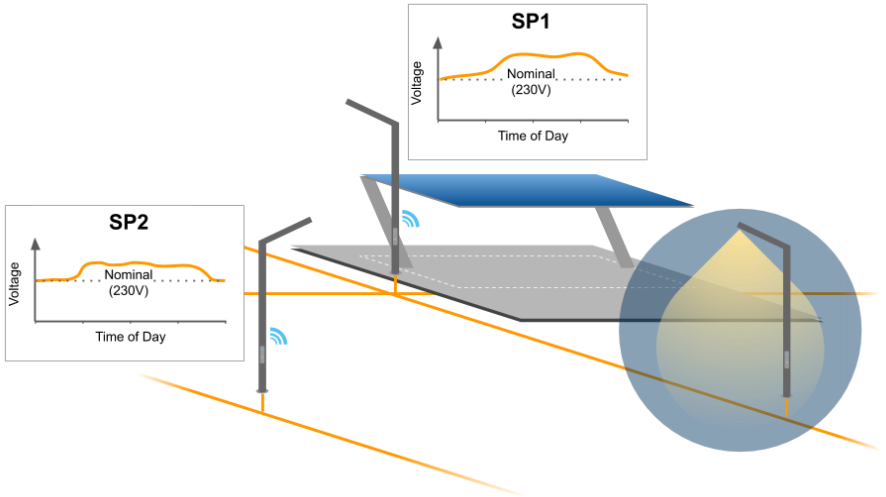
Automatic Topology Identification

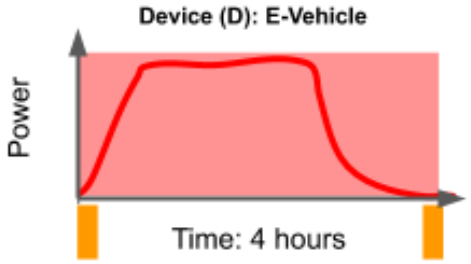
- The information of the underlying network topology is essential for efficient integration and management of controllable loads (electro-mobility) in weak LV networks.
- A major challenge in topology identification is having access to accurate network data. The knowledge of topology and/or impedance matrix (representing node-to-node impedance of the network) is often unavailable in LV distribution networks.

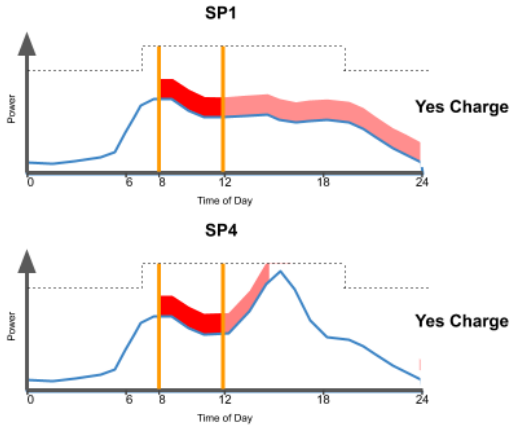


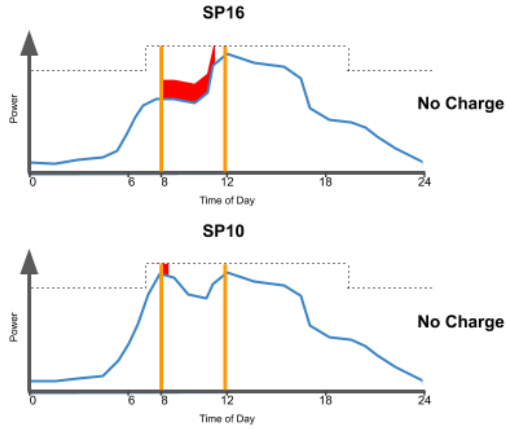
Dynamic Power Calculation





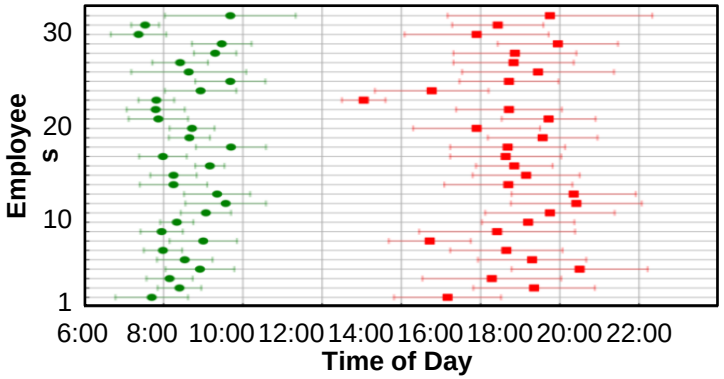




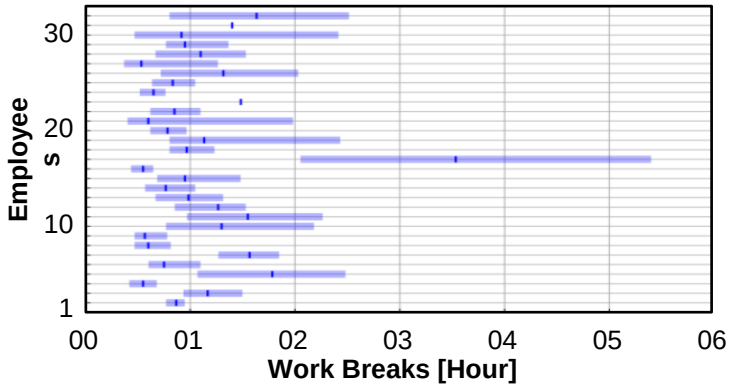


E-mobility Profile Generation

Employee In & Out Data



Work Breaks of Employees



Average Day Profile

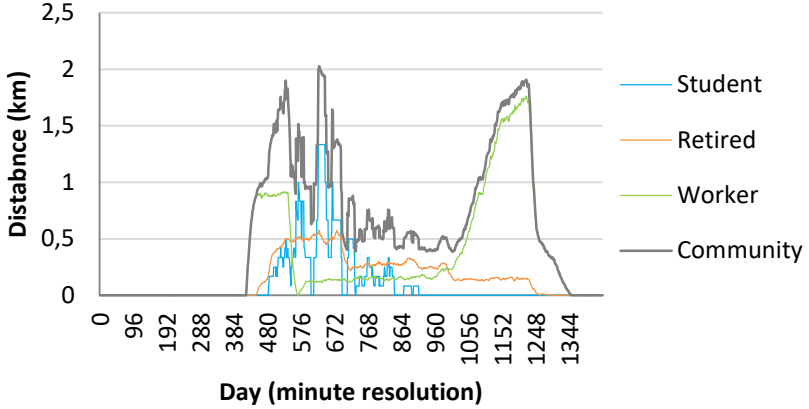


Table 1: Micro-mobility Application profile

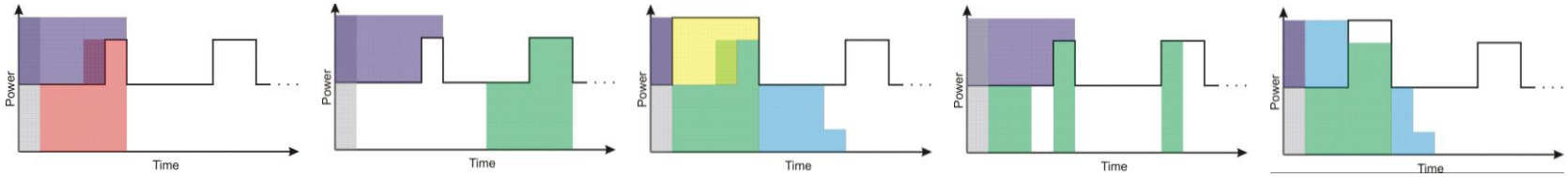
E-scooter range	48 km [28]
E-scooter average speed	9.13 km/h [29]
E-scooter consumption	633 Wh/km [30]

Table 2: Community profile

Community size/users	100 user (Oldenburg, Germany
User types	Student, Worker, Retired
Community area/size	A round area of 5 km diameter
Points of interest	Grocery, Café, Shopping, University, Gathering, Hospital
Charging stations	4 (uniformly/equally-distance spread),

Development of Load Management Strategies

- The strategies are intended to operate low voltage distribution networks close to their physical and operational limits, which are the current rating of the cables and the voltage level for the safe operation of the applied load.
- Maximizing the **load acceptance rate (%)** and the **total delivered energy (MWh)** are identified as the two main parameters to be calculated, optimized and compared amongst strategies.



a) Immediate Acceptance (IA)

b) Time Based Shift as Whole (TSW)

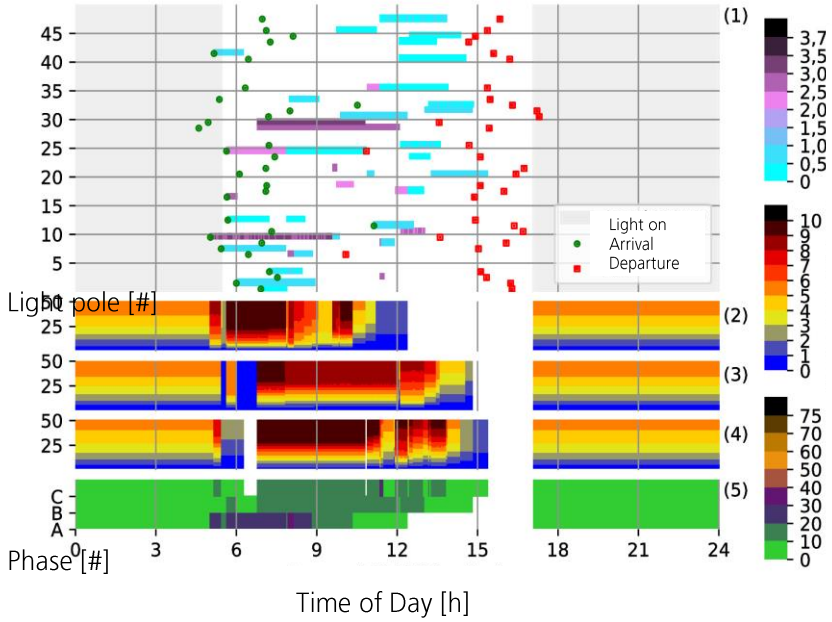
c) Time Based Shift & Dispatching for All Remaining Loads (TSD)

d) Time based Shift and Split (TSS)

e) Optimized Split (OS)

Results

Results (Acceptance rate [%] & Delivered energy [MWh])



Acceptance rate [%]

	Stab line network		Random network	
	Work	Residence	Work	Residence
IA	52,52	57,12	85,34	93,37
TSW	79,41	75,4	98,85	99,87
TSD	80,17	75,72	99,6	99,93
TSS	80,2	75,54	98,9	99,88

Delivered energy [MWh]

	Stab line network		Random network	
	Work	Residence	Work	Residence
IA	8,15	8,16	18,39	20,07
TSW	13,93	10,59	22,16	22,08
TSD	14,17	10,73	22,54	22,14
TSS	14,28	10,76	22,18	22,11

Thank you!

Acknowledgment

This work was carried out as part of the project “Smarte Pfosten” (smart lighting pole in English) and is funded by the ZIM program of the Federal Ministry for Economic Affairs (16KN062820).